1		Use law for the logarithm of a product, power or quotient	M1*	
		Obtain a correct linear equation, e.g. $(2x-1)\ln 5 = \ln 2 + x\ln 3$	A1	
		Solve a linear equation for x	M1(dep*)	
		Obtain answer $x = 1.09$	A1	[4]
		[SR: Reduce equation to the form $a^x = b$ M1*, obtain $\left(\frac{25}{3}\right)^x = 10$ A1, use correct method to calculate value of x M1(dep*), obtain answer 1.09 A1.]		
2		Use correct quotient or product rule	M1	
		Obtain correct derivative in any form, e.g. $-\frac{3\ln x}{x^4} + \frac{1}{x^4}$	A1	
		Equate derivative to zero and solve for x an equation of the form $\ln x = a$, where $a > 0$	M1	
		Obtain answer $\exp(\frac{1}{3})$, or 1.40, from correct work	A1	[4]
3		Attempt integration by parts and reach $k(1-x)e^{-\frac{1}{2}x} \pm k\int e^{-\frac{1}{2}x}\,dx$, or equivalent	M1	
		Obtain $-2(1-x)e^{-\frac{1}{2}x} - 2\int e^{-\frac{1}{2}x}\,dx$, or equivalent	A1	
		Integrate and obtain $-2(1-x)e^{-\frac{1}{2}x} + 4e^{-\frac{1}{2}x}$, or equivalent	A1	
		Use limits $x = 0$ and $x = 1$, having integrated twice	M1	
		Obtain the given answer correctly	A1	[5]
4	**(i)**	Use $\tan(A \pm B)$ formula correctly at least once and obtain an equation in $\tan\theta$	M1	
		Obtain a correct horizontal equation in any form	A1	
		Use $\tan 60° = \sqrt{3}$ throughout	M1	
		Obtain the given equation correctly	A1	[4]
	(ii)	Set $k = 3\sqrt{3}$ and obtain $\tan^2\theta = \frac{1}{11}$	B1	
		Obtain answer 16.8°	B1√	
		Obtain answer 163.2°	B1√	[3]
		[Ignore answers outside the given interval. Treat answers in radians (0.293 and 2.85) as a misread.]		

5	**(i)**	Substitute $x = \frac{1}{2}$ and equate to zero, or divide, and obtain a correct equation, e.g. $\frac{1}{8}a + \frac{1}{4}b + \frac{5}{2} - 2 = 0$	B1	
		Substitute $x = 2$ and equate result to 12, or divide and equate constant remainder to 12	M1	
		Obtain a correct equation, e.g. $8a + 4b + 10 - 2 = 12$	A1	
		Solve for a or for b	M1	
		Obtain $a = 2$ and $b = -3$	A1	[5]
	(ii)	Attempt division by $2x - 1$ reaching a partial quotient $\frac{1}{2}ax^2 + kx$	M1	
		Obtain quadratic factor $x^2 - x + 2$	A1	[2]
		[The M1 is earned if inspection has an unknown factor $Ax^2 + Bx + 2$ and an equation in A and/or B, or an unknown factor of $\frac{1}{2}ax^2 + Bx + C$ and an equation in B and/or C.]		
6	**(i)**	Make recognisable sketch of a relevant graph over the given range	B1	
		Sketch the other relevant graph and justify the given statement	B1	[2]
	(ii)	Consider the sign of $\cot x - (1 + x^2)$ at $x = 0.5$ and $x = 0.8$, or equivalent	M1	
		Complete the argument with correct calculated values	A1	[2]
	(iii)	Use the iterative formula correctly at least once with $0.5 \le x_n \le 0.8$	M1	
		Obtain final answer 0.62	A1	
		Show sufficient iterations to 4 d.p. to justify its accuracy to 2 d.p., or show there is a sign change in the interval (0.615, 0.625)	A1	[3]
7	**(i)**	Use the quadratic formula, completing the square, or the substitution $z = x + iy$ to find a root and use $i^2 = -1$	M1	
		Obtain final answers $-\sqrt{3} \pm i$, or equivalent	A1	[2]
	(ii)	State that the modulus of both roots is 2	B1√	
		State that the argument of $-\sqrt{3} + i$ is 150° or $\frac{5}{6}\pi$ (2.62) radians	B1√	
		State that the argument of $-\sqrt{3} - i$ is –150° (or 210°) or $-\frac{5}{6}\pi$ (–2.62) radians or $\frac{7}{6}\pi$ (3.67) radians	B1√	[3]
	(iii)	Carry out an attempt to find the sixth power of a root	M1	
		Verify that one of the roots satisfies $z^6 = -64$	A1	
		Verify that the other root satisfies the equation	A1	[3]

8	**(i)**	Use product and chain rule	M1	
		Obtain correct derivative in any form, e.g. $15\sin^2 x\cos^3 x - 10\sin^4 x\cos x$	A1	
		Equate derivative to zero and obtain a relevant equation in one trigonometric function	M1	
		Obtain $2\tan^2 x = 3$, $5\cos^2 x = 2$, or $5\sin^2 x = 3$	A1	
		Obtain answer $x = 0.886$ radians	A1	[5]
	(ii)	State or imply $\mathrm{d}u = -\sin x\,\mathrm{d}x$, or $\frac{\mathrm{d}u}{\mathrm{d}x} = -\sin x$, or equivalent	B1	
		Express integral in terms of u and $\mathrm{d}u$	M1	
		Obtain $\pm\int 5\left(u^2 - u^4\right)\mathrm{d}u$, or equivalent	A1	
		Integrate and use limits $u = 1$ and $u = 0$ (or $x = 0$ and $x = \frac{1}{2}\pi$)	M1	
		Obtain answer $\frac{2}{3}$, or equivalent, with no errors seen	A1	[5]
9	**(i)**	State or imply $\frac{\mathrm{d}x}{\mathrm{d}t} = k(10 - x)(20 - x)$ and show $k = 0.01$	B1	[1]
	(ii)	Separate variables correctly and attempt integration of at least one side	M1	
		Carry out an attempt to find A and B such that $\frac{1}{(10 - x)(20 - x)} \equiv \frac{A}{10 - x} + \frac{B}{20 - x}$, or equivalent	M1	
		Obtain $A = \frac{1}{10}$ and $B = -\frac{1}{10}$, or equivalent	A1	
		Integrate and obtain $-\frac{1}{10}\ln(10 - x) + \frac{1}{10}\ln(20 - x)$, or equivalent	A1√	
		Integrate and obtain term $0.01t$, or equivalent	A1	
		Evaluate a constant, or use limits $t = 0$, $x = 0$, in a solution containing terms of the form $a\ln(10 - x)$, $b\ln(20 - x)$ and ct	M1	
		Obtain answer in any form, e.g. $-\frac{1}{10}\ln(10 - x) + \frac{1}{10}\ln(20 - x) = 0.01t + \frac{1}{10}\ln 2$	A1√	
		Use laws of logarithms to correctly remove logarithms	M1	
		Rearrange and obtain $x = 20(\exp(0.1t) - 1)/(2\exp(0.1t) - 1)$, or equivalent	A1	[9]
	(iii)	State that x approaches 10	B1	[1]

10 (i)	*EITHER*:	Express general point of l or m in component form, e.g. $(2+\lambda, -\lambda, 1+2\lambda)$ or $(\mu, 2+2\mu, 6-2\mu)$	B1	
		Equate at least two pairs of components and solve for λ or for μ	M1	
		Obtain correct answer for λ or μ (possible answers for λ are -2, $\frac{1}{4}$, 7 and for μ are 0, $2\frac{1}{4}$, $-4\frac{1}{2}$)	A1	
		Verify that all three component equations are not satisfied	A1	
	OR:	State a relevant scalar triple product, e.g. $(2\mathbf{i}-2\mathbf{j}-5\mathbf{k})\,.\,((\mathbf{i}-\mathbf{j}+2\mathbf{k})\times(\mathbf{i}+2\mathbf{j}-2\mathbf{k}))$	B1	
		Attempt to use the correct method of evaluation	M1	
		Obtain at least two correct simplified terms of the three terms of the expansion of the triple product or of the corresponding determinant, e.g. $-4, -8, -15$	A1	
		Obtain correct non-zero value, e.g. -27, and state that the lines do not intersect	A1	[4]
(ii)		Carry out the correct process for evaluating scalar product of direction vectors for l and m	M1	
		Using the correct process for the moduli, divide the scalar product by the product of the moduli and evaluate the inverse cosine of the result	M1	
		Obtain answer 47.1° or 0.822 radians	A1	[3]
(iii)	*EITHER*:	Use scalar product to obtain $a-b+2c=0$	B1	
		Obtain $a+2b-2c=0$, or equivalent, from a scalar product, or by subtracting two point equations obtained from points on m, and solve for one ratio, e.g. $a:b$	M1*	
		Obtain $a:b:c=-2:4:3$, or equivalent	A1	
		Substitute coordinates of a point on m and values for a, b and c in general equation and evaluate d	M1(dep*)	
		Obtain answer $-2x+4y+3z=26$, or equivalent	A1	
	OR1:	Attempt to calculate vector product of direction vectors of l and m	M1*	
		Obtain two correct components	A1	
		Obtain $-2\mathbf{i}+4\mathbf{j}+3\mathbf{k}$, or equivalent	A1	
		Form a plane equation and use coordinates of a relevant point to evaluate d	M1(dep*)	
		Obtain answer $-2x+4y+3z=26$, or equivalent	A1	
	OR2:	Form a two-parameter plane equation using relevant vectors	M1*	
		State a correct equation e.g. $\mathbf{r}=2\mathbf{j}+6\mathbf{k}+\mathbf{s}(\mathbf{i}-\mathbf{j}+2\mathbf{k})+\mathbf{t}(\mathbf{i}+2\mathbf{j}-2\mathbf{k})$	A1	
		State three correct equations in x, y, z, s and t	A1	
		Eliminate s and t	M1(dep*)	
		Obtain answer $-2x+4y+3z=26$, or equivalent	A1	[5]